LANCASTER UNIVERSITY

Cockcroft Institute

ASTeC

Problems associated with the Crab Cavity

Crab Cavity Meeting

14/4/2005

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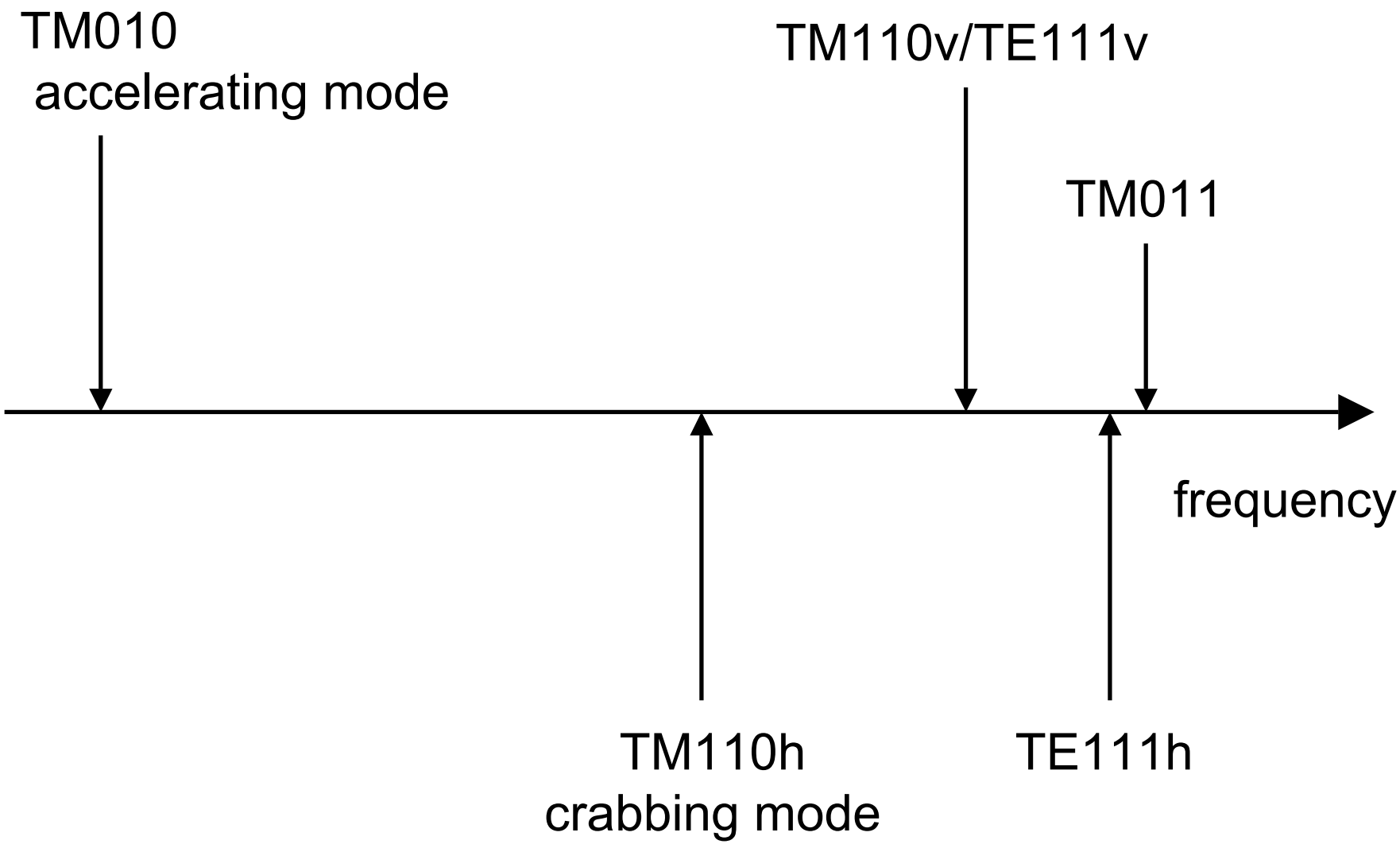
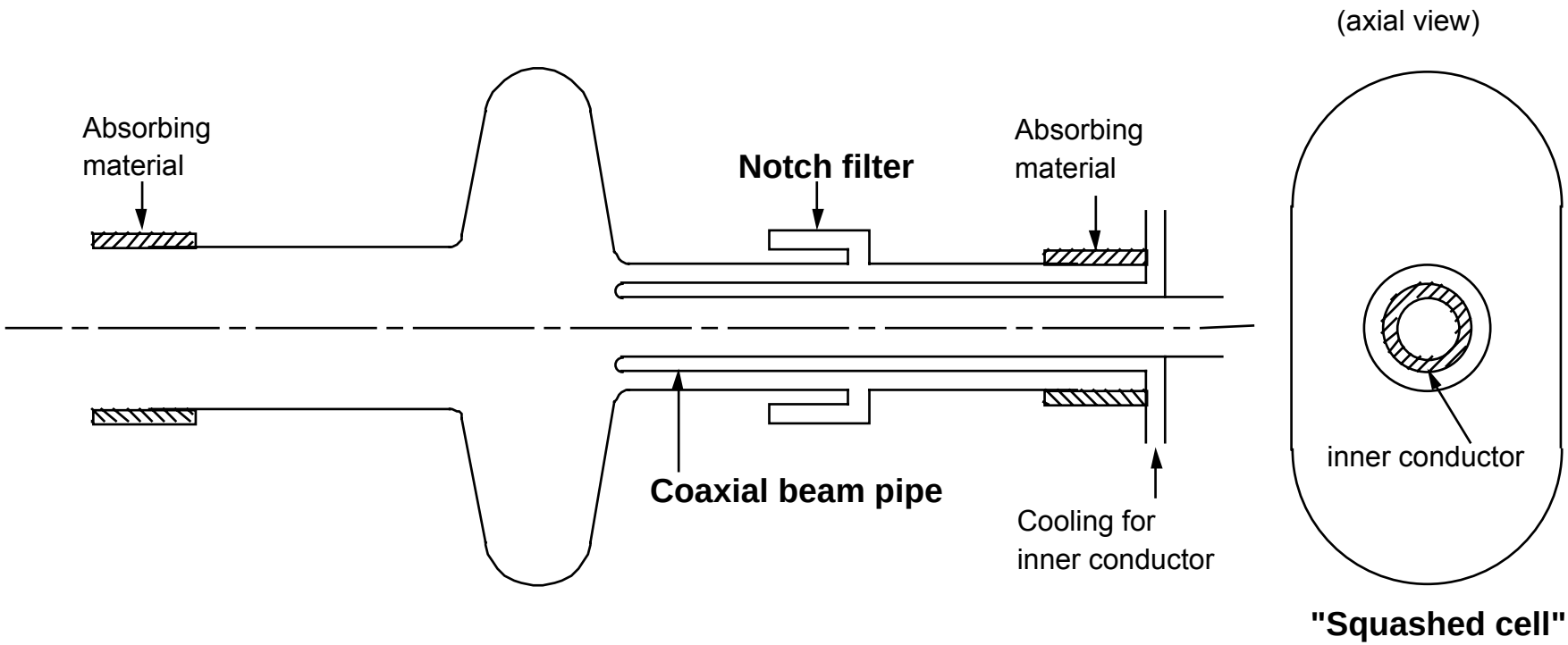
Sources of error

- HOM/LOM
- Microphonics
- Cavity Asymmetry
- Voltage Error
- Phase Error
- Differential Phase Jitter

Order of modes in an elliptical cavity



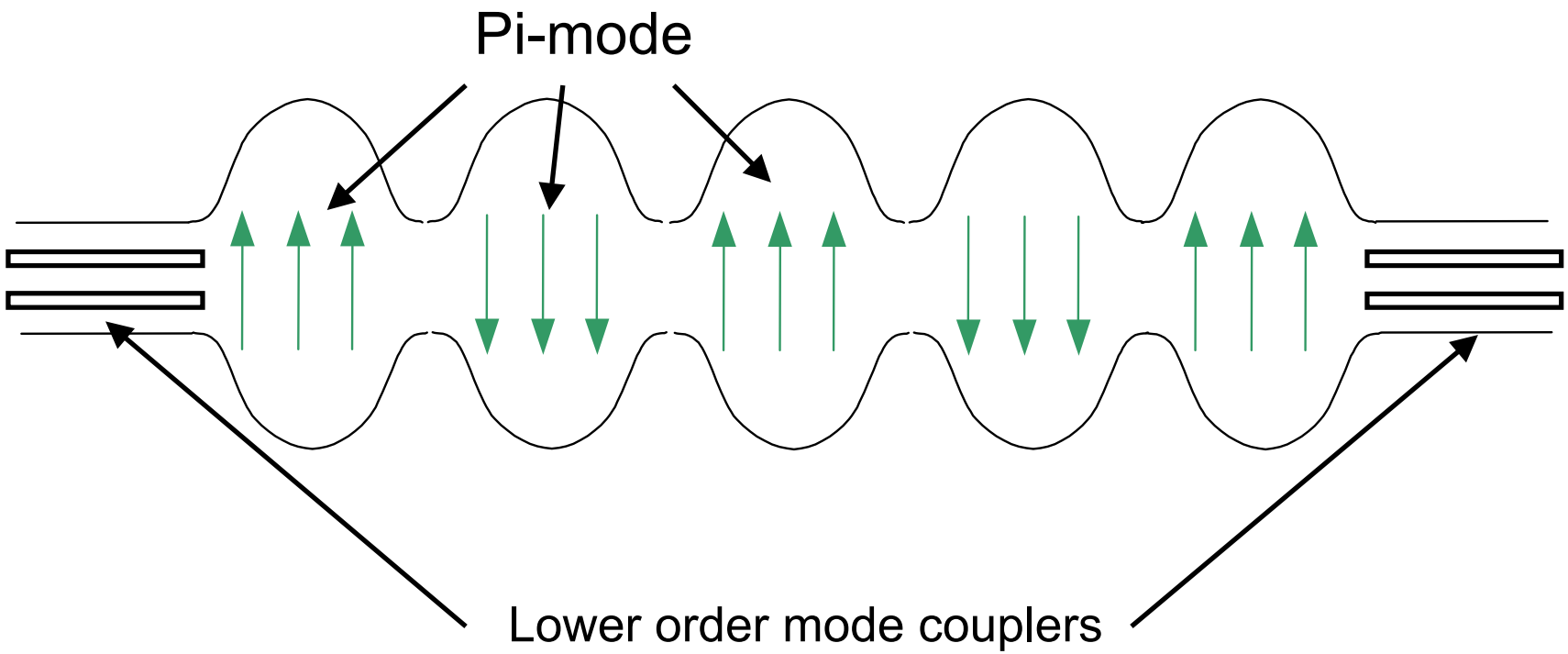
KEKB Crab Cavity



Squashed Crab cavity for B-factories

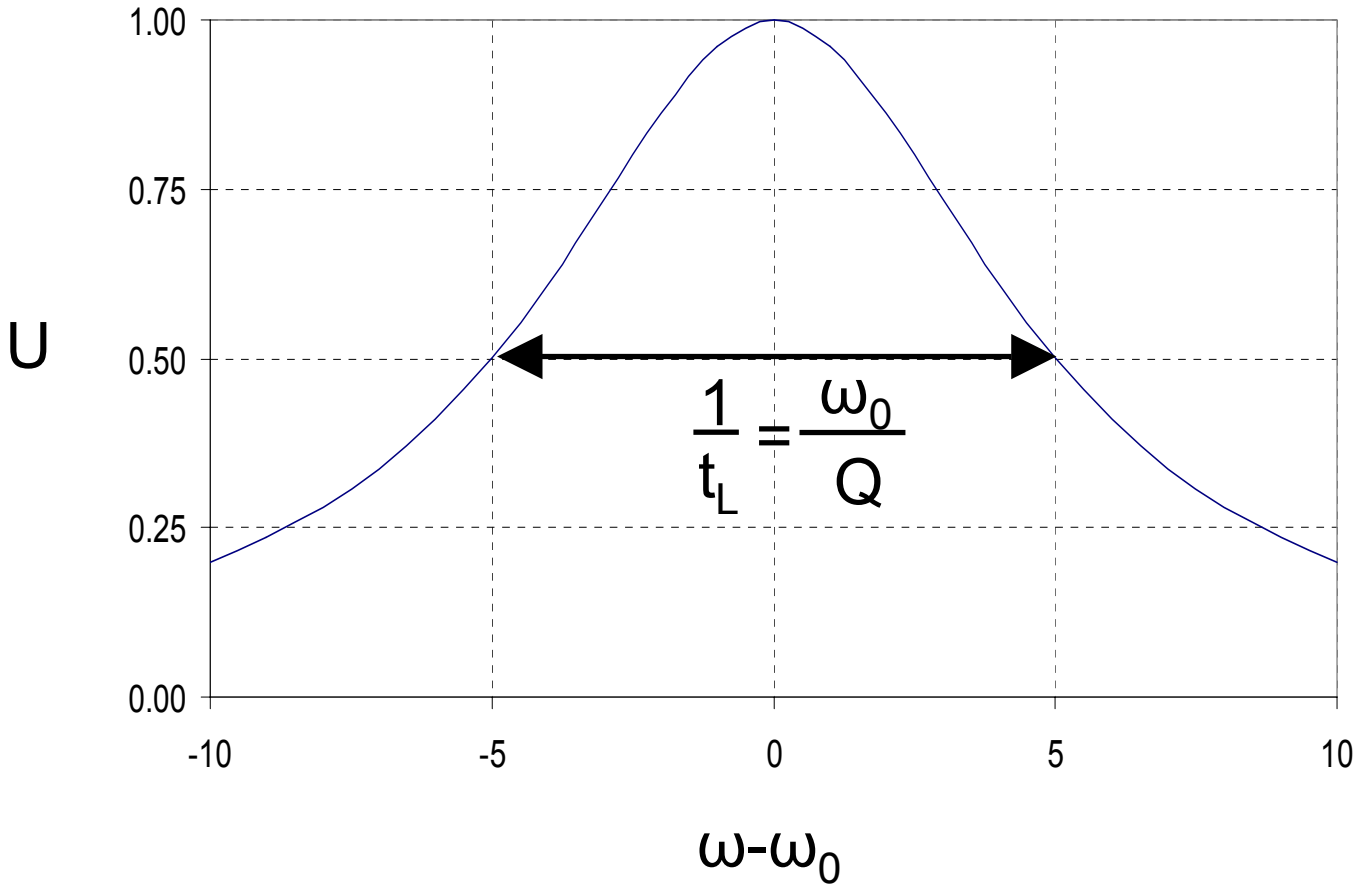
(K. Akai et al., Proc. B-factories, SLAC-400 p.181 (1992).)

Multicell cavities



Difficult to damp LOMs in the middle cells.

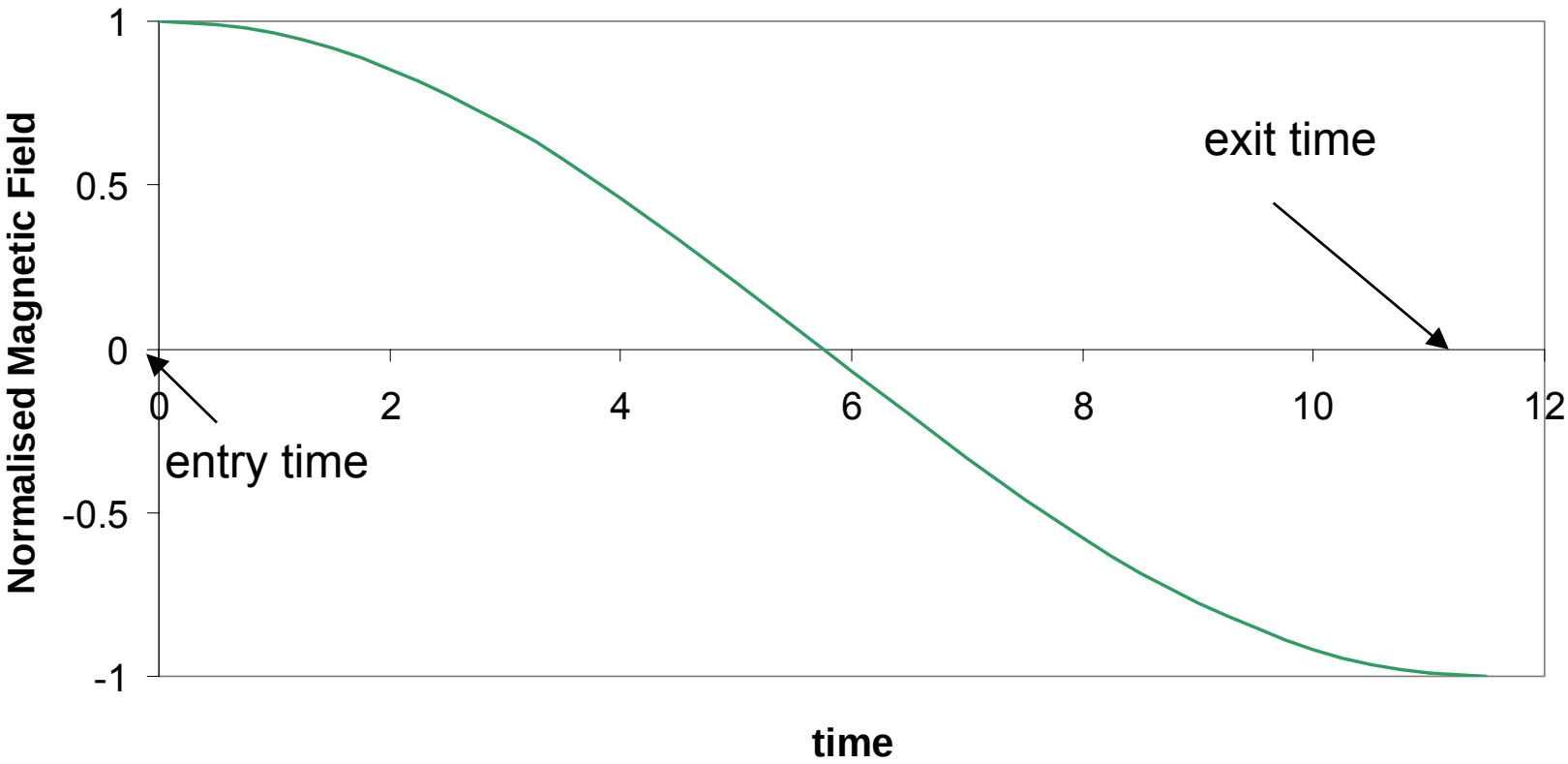
Resonant bandwidth



Large bandwidth reduces problems due to microphonics

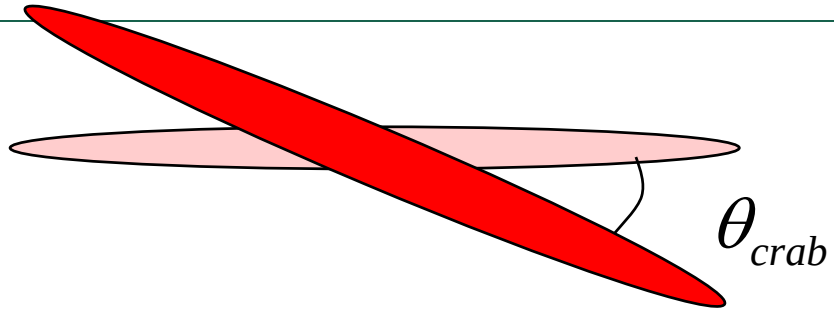
Cavity Asymmetry

- Magnetic field as seen by the middle of the bunch as a function of position across the cavity.



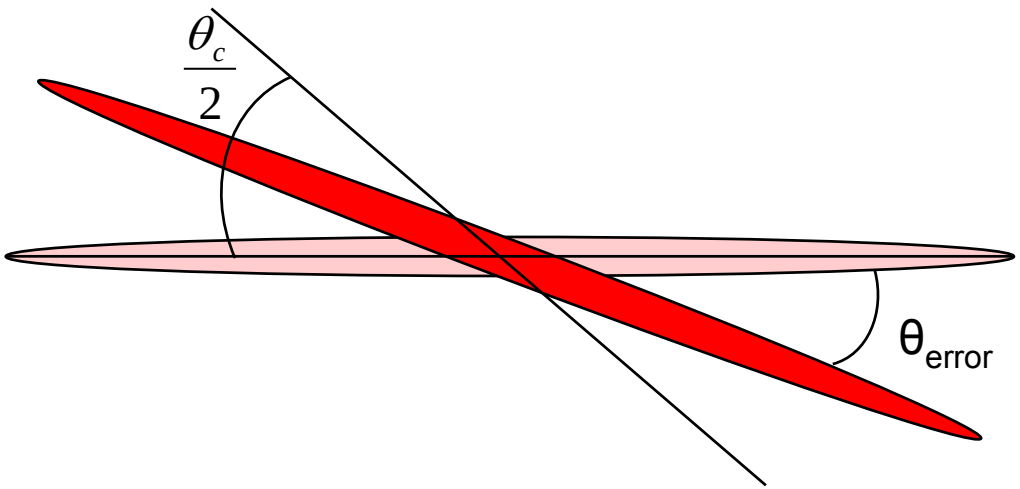
Voltage Stability

For optimum cell length



θ_{crab} is proportional to the maximum magnetic field in the cavity

voltage error induces errors in bunch rotation

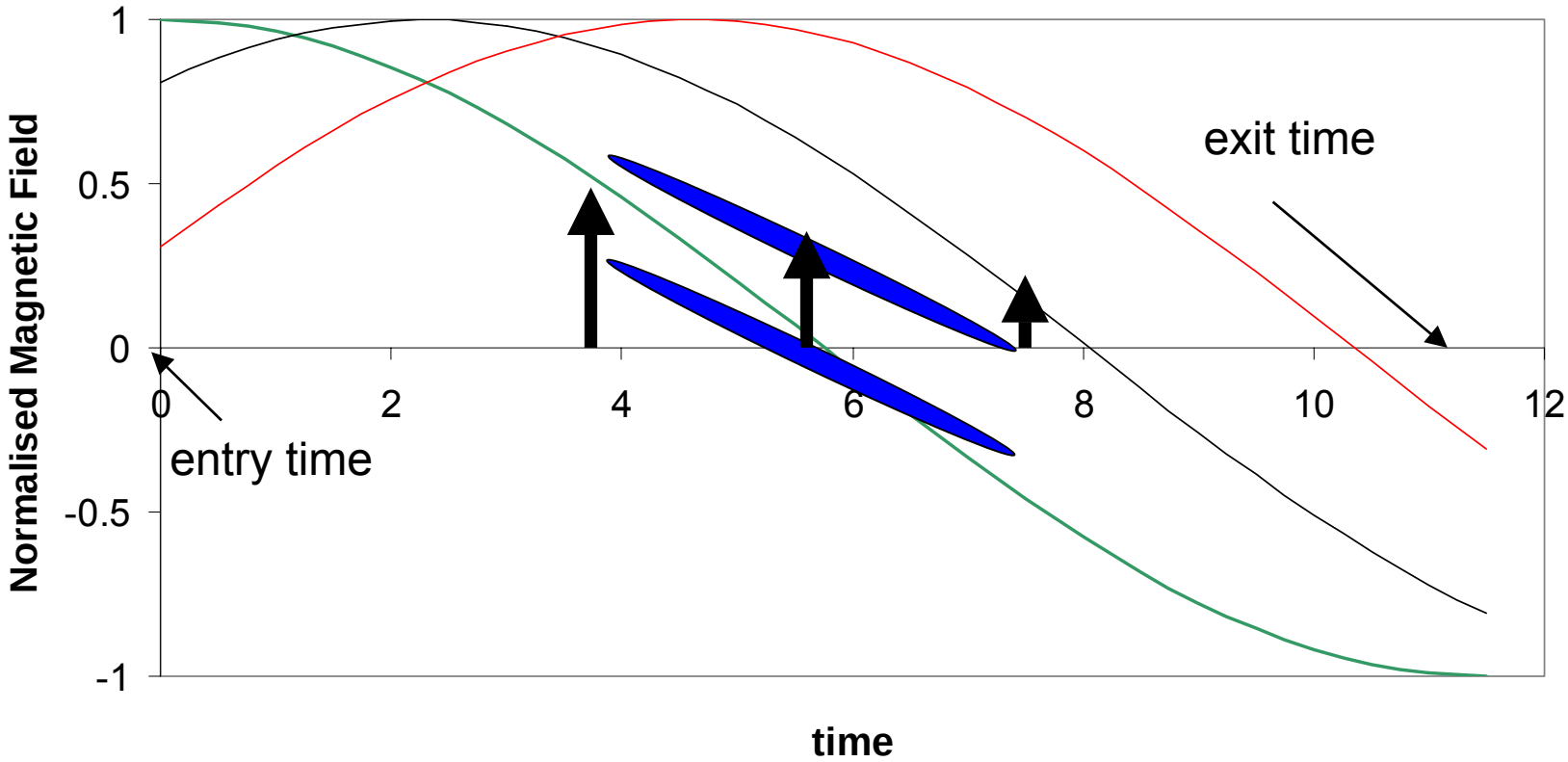


Crossing Angle	Voltage Stability
2mrad	33%
10mrad	7%
20mrad	3%

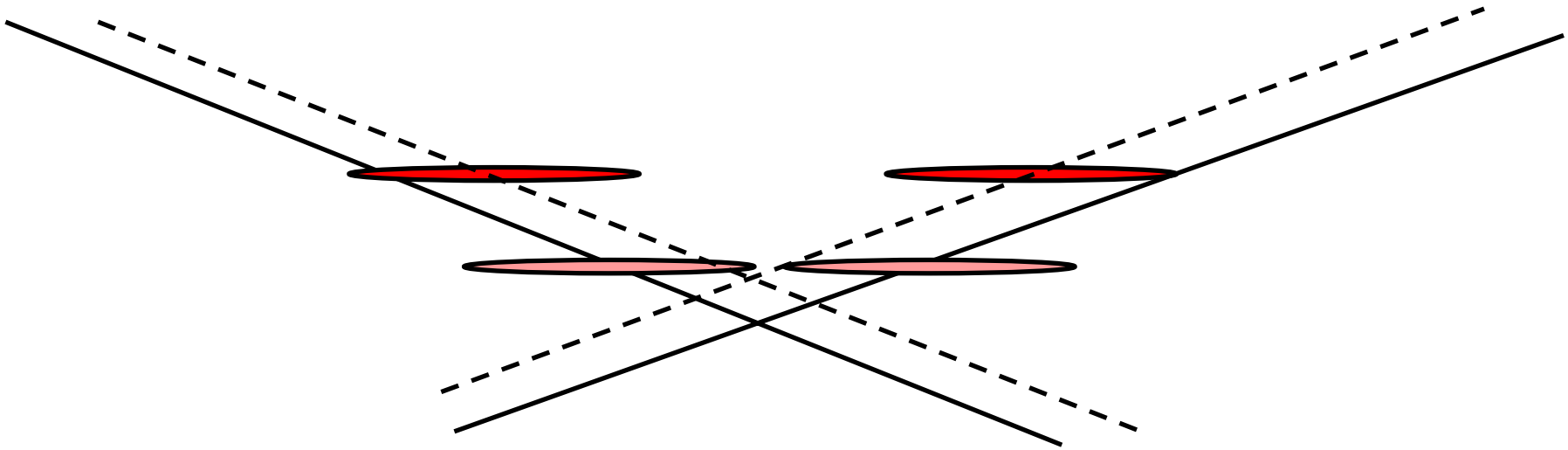
(using ILC parameters for 2 % luminosity loss)

Absolute phase error: Transverse deflecting dipole mode

- Magnetic field as seen by front, middle, and back of the bunch as a function of position across the cavity for phase error.



Absolute phase error: Transverse deflecting dipole mode

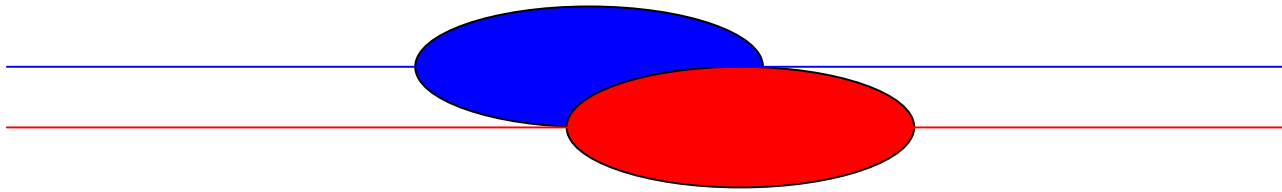


	1.3GHz	3.9GHz
Crossing Angle	Phase Error	(degrees)
2mrad	31	93
10mrad	6	19
20mrad	3	9

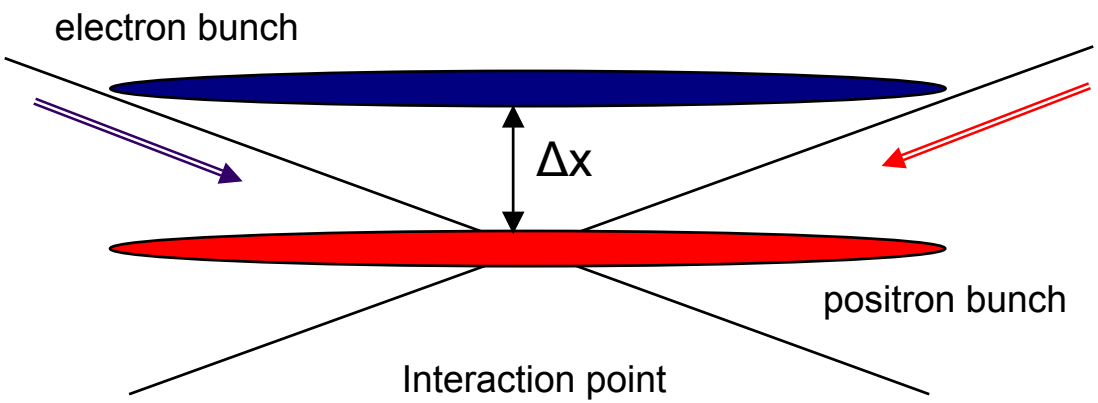
For a 2% luminosity loss

Phase Jitter

Crabbed Crossing Angle with Phase jitter



Effective head-on collision

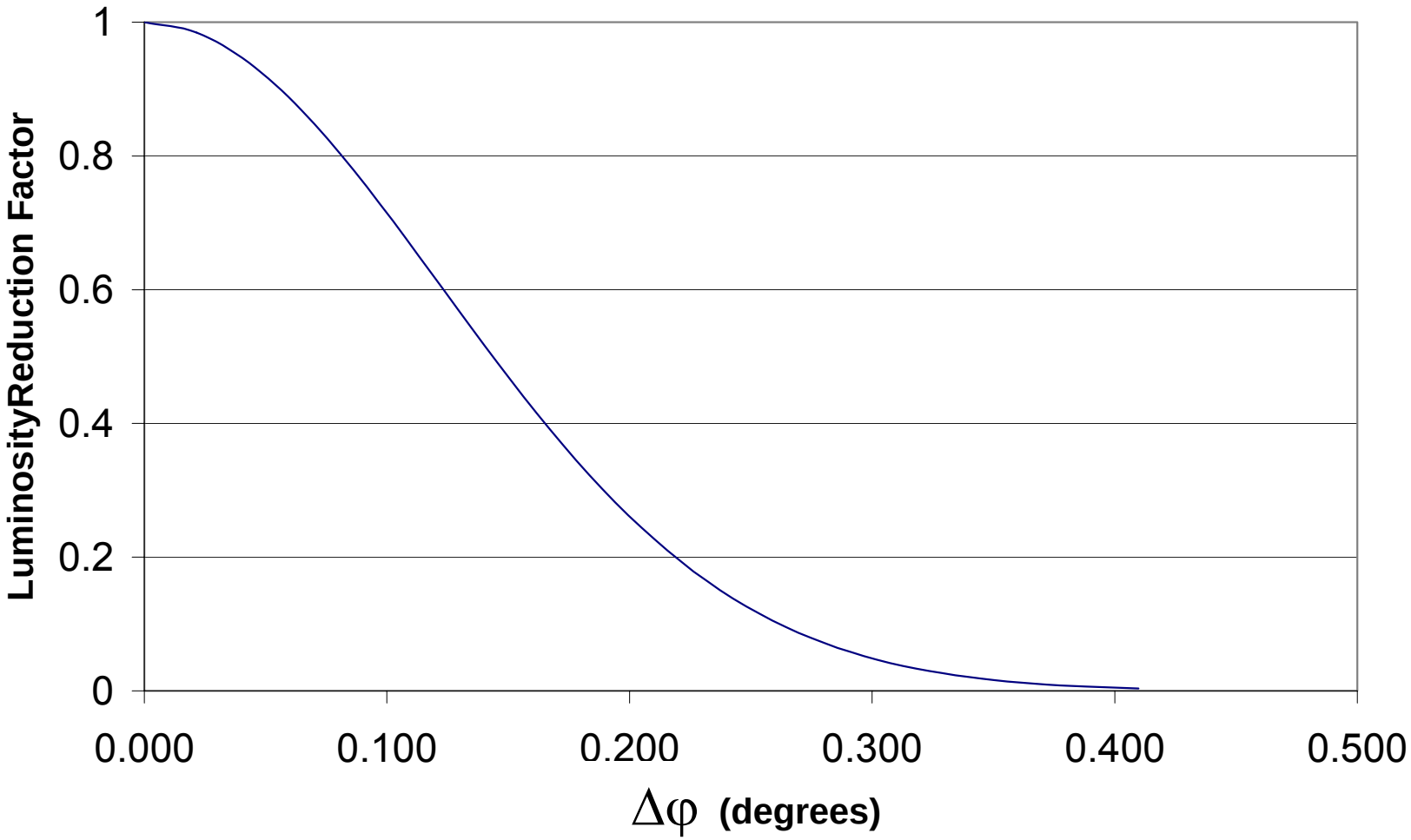


$$\Delta x \propto \frac{\theta_r \sin(\Delta\varphi)}{\omega}$$

Phase jitter for a 2% luminosity loss

	1.3GHz	3.9GHz
Crossing Angle	Phase Error	degrees
2mrad	0.222	0.665
10mrad	0.044	0.133
20mrad	0.022	0.066

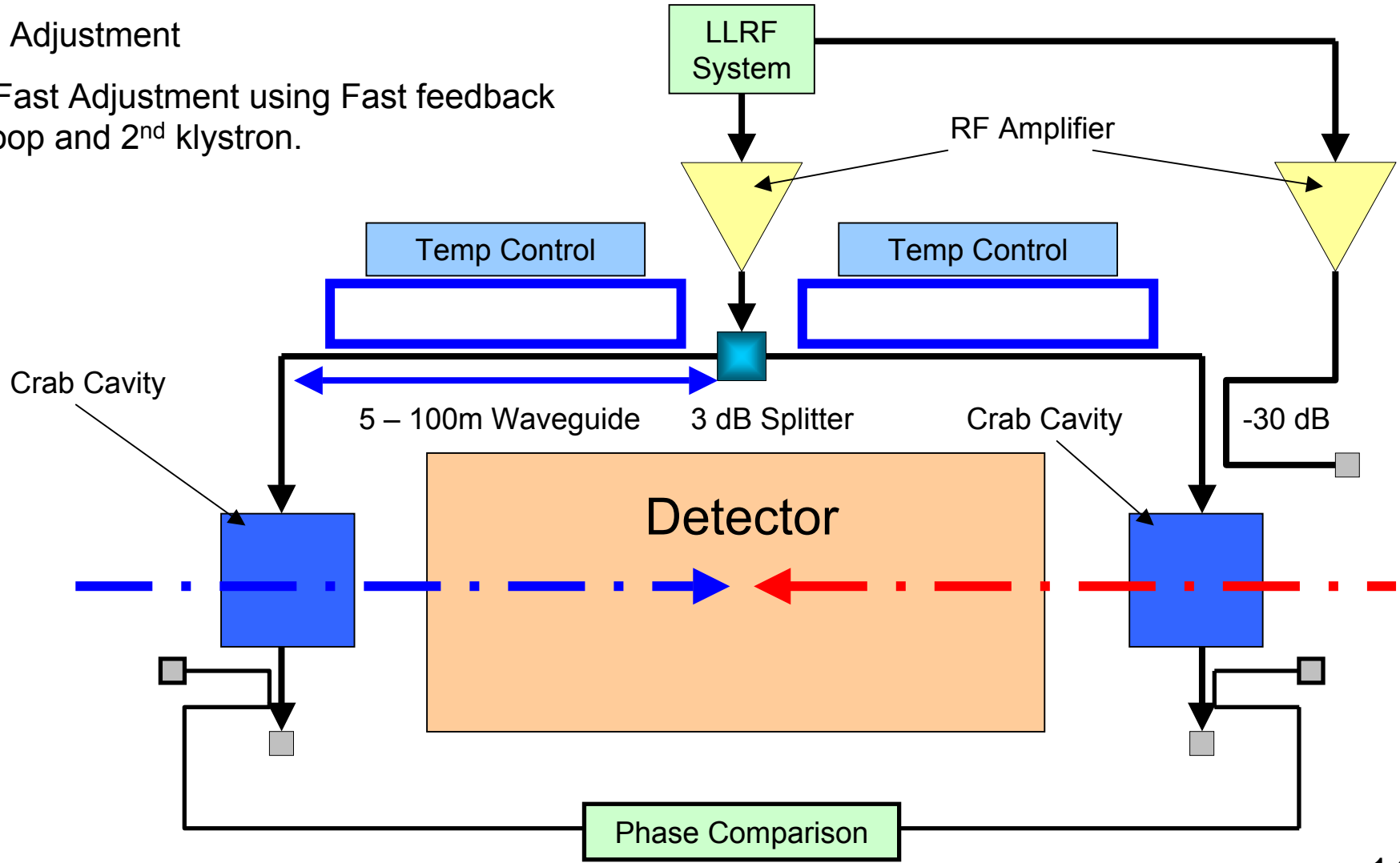
Loss of luminosity with jitter for a 20mrad crossing angle



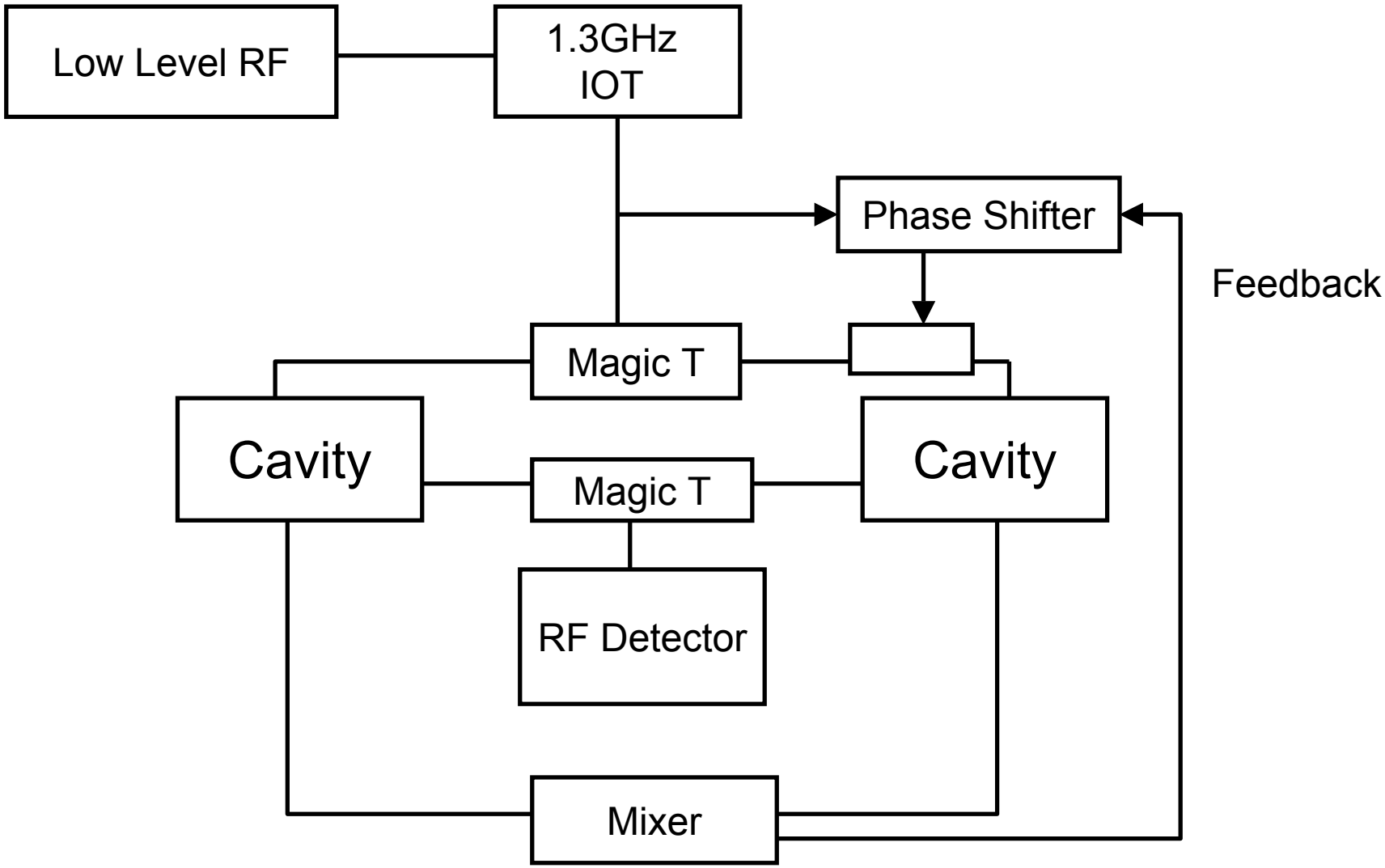
Crab cavity phase control system

Phase Adjustment

- Fast Adjustment using Fast feedback loop and 2nd klystron.



Daresbury Experiment



Experimental plan

- Phase stability experiment
  - Verify ability to measure phase error
  - Correct phase using feedback loop
  - Test on ERLP SRF cavities

Conclusion

- LOM damping in multi-cell cavities will be looked at
- Voltage Stability will not be a problem but voltage asymmetry due to microphonics may be.
- The biggest single obstacle will be phase jitter between the cavities